NEW RECORDS OF BUTTERFLIES (LEPIDOPTERA) IN THE PILBARA REGION OF WESTERN AUSTRALIA, WITH COMMENTS ON THE USE OF MALAISE TRAPS FOR MONITORING

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Abstract

New distribution records, range extensions and temporal data are presented for *Taractrocera anisomorpha* (Lower), *Proeidosa polysema* (Lower), *Zizina labradus labradus* (Godart), *Zizula hylax attenuata* (T.P. Lucas), *Candalides erinus* (Fabricius), *Candalides heathi heathi* (Cox), *Famegana alsulus alsulus* (Herrich-Schäffer), *Theclinesthes serpentata serpentata* (Herrich-Schäffer), *Euploea core corinna* (Cramer), *Hypolimnas bolina nerina* (Fabricius), *Elodina walkeri* Butler and *Delias aganippe* (Donovan) from the Pilbara region, Western Australia. New temporal data for *Jalmenus clementi* H.H. Druce, *Theclinesthes miskini miskini* (T.P. Lucas), *Nacaduba biocellata biocellata* (C. & R. Felder), *Ogyris amaryllis meridionalis* (Bethune-Baker), *Ogyris oreotes* (Hewitson), *Vanessa kershawi* (McCoy) and *Elodina padusa* (Hewitson) in Western Australia are also presented. The potential benefits of Malaise trapping for long term monitoring of butterflies in remote locations are discussed.

Introduction

The Pilbara region of west-central Western Australia makes a significant contribution to the Australian economy due to its rich iron ore reserves. The geological features are well known, but the regional biodiversity is poorly understood. In recent years, survey effort by the Western Australian Government Department of Conservation, the private sector and partners has increased in order to build the biological knowledge base of the Pilbara. The Australian Museum, in partnership with the mining company Rio Tinto, initiated the BioMaps: Pilbara Regional Program, which aims to contribute to the description and characterisation of the Pilbara invertebrate fauna by correlating the species richness of select invertebrate taxa with a range of spatial, temporal, climatic and disturbance variables within the region.

A component of this program was the establishment of long term monitoring stations across the Central Pilbara region (southern reaches of the Hamersley subregion -PIL3) (Naturebase 2006). Each station consisted of a Malaise trap and a pitfall trap. The examination of Malaise trap catches, in conjunction with opportunistic observations and collections during the study, gave an insight into butterfly diversity and seasonality throughout the Central Pilbara region. This work highlights the potential value of Malaise traps as a tool for collecting information on butterfly populations in remote areas.

Materials and methods

Site descriptions

Long-term monitoring sites were established at five locations on Hamersley Station and three locations on Juna Downs Station in the Pilbara region. Site

locations were selected to represent four vegetation structures dominant in this region:

(1) Short bunch grassland – kangaroo grass *Themeda* spp. (Poaceae);

(2) Low woodland – mulga *Acacia aneura* group;

(3) Hummock grasslands, low tree steppe – snappy gum *Eucalyptus brevifolia* F.Muell. (Myrtaceae) over limestone spinifex *Triodia wiseana* C.A. Gardner (Poaceae);

(4) Hummock grassland, shrub steppe – mulga *Acacia aneura* group, kanji *Acacia pyrifolia* D.C., *A. inaequilatera* Domin over soft spinifex *Triodia pungens* R.Br. and lobed spinifex *Triodia basedowii* E.Pritz.

An additional station was placed in snakewood *Acacia xiphophylla* E.Pritz shrubland.

Sampling

Each site was sampled using one Malaise trap (Light-Weight Townes Trap Model 3412) and one pitfall trap (95 mm diameter). Both traps used ethylene glycol as a preservative. Samples were taken at six-weekly intervals from May 2004 to May 2006, resulting in 12 sampling events (Table 1). Traps were operated for five days per sample. The material was transported in the original ethylene glycol to the Australian Museum, Sydney for identification and curation. They were then transferred to 80% ethanol. Selected specimens were removed, dried, relaxed and set for detailed examination of wing patterns and other characters. Identification was based on comparison with specimens in the collection at the Australian Museum or by using Braby (2000). All specimens examined are held in the Australian Museum collection. Unless otherwise stated, all specimens listed are from the Pilbara region and were captured using malaise traps.

Opportunistic sweep netting was also conducted throughout broad-scale survey periods and the occasional long-term sampling periods.

Results

Of the 526 butterfly specimens collected in this study, 524 were identified. Twenty-four species were recorded, compared with the nine species previously recorded from the Hamersley subregion. Nineteen of the 35 species known from the Pilbara region (Dunn and Dunn 1991, Braby 2000) were identified during the survey, together with five species not recorded previously. Seventeen species were collected by Malaise trap, with the remainder recorded as opportunistically netted specimens or based on reliable sightings.

Significant range extensions were noted for 12 of the butterfly species. These ranged from 50 to 1700 km from the nearest historical records. The data set also revealed previously undocumented information on adult flight period for many of the species collected.

Table 1. Sampling dates for long term monitoring survey conducted in the Pilbara Region, W.A. using malaise and pitfall traps. Sampling in May 2004 was part of an initial broad scale survey. Sampling was conducted as close as possible to six-weekly intervals from September 2004 to January 2006. No sampling event was conducted in January 2005, due to field staff unavailability.

Sampling Event	Range of Sampling Dates
1	27-30 May 2004
2	30 Sep – 6 Oct 2004
3	18-24 Nov 2004
4	16-20 Feb 2005
5	13-18 April 2005
6	19-25 May 2005
7	6-12 July 2005
8	12-17 Aug 2005
9	22-28 Sep 2005
10	28 Oct – 2 Nov 2005
11	3-8 Jan 2006
12	15-19 May 2006 *

* Sampling in March washed out by cyclone.

Species accounts

HESPERIIDAE

Proeidosa polysema (Lower)

Material examined. 1 ♂, 13-18.iv.2005, 4 km southwest of Tom Price Junction, Nanutarra-Munjina Road, 22°29'S 117°41'E, CVA volunteers.

In the Pilbara region, *P. polysema* was known previously only from Exmouth and Vlaming Head (Dunn and Dunn 1991). A shelter and larva of *P. polysema* were observed 40 km west of the Yannarie River (Johnson and Valentine 2004). The above record extends the range inland by about 310 km. The specimen resembles the 'small-spot form' rather than the 'large-spot form' which has been associated with populations of this species in Western Australia and Northern Territory (Braby 2000). An April flight date for this species has not been recorded previously from northern Western Australia.

Taractrocera anisomorpha (Lower)

Material examined. 1 ♂, 16-20.ii.2005, Nanutarra-Wittenoom Rd, 10.8 km northeast of Tom Price Junction, 22°26'S 117°48'E, M. Bulbert & S. Ginn.

On mainland W.A., *T. anisomorpha* was previously recorded only from the Fortescue River (exact location unknown: Dunn and Dunn 1991) and Learmonth, 22 km south of Exmouth on North West Cape (Williams *et al.* 1996). The above specimen confirms that the species' range extends inland approximately 300 km. Previous records from northern Western Australia were in February (Williams *et al.* 1996) and May (Dunn and Dunn 1991).

PIERIDAE

Elodina padusa (Hewitson)

Material examined. 1 ♂, 28.x.2005-2.xi.2005, 1 ♂, 15.v.2006-19.v.2006, Nanutarra-Wittenoom Rd, 26.6 km northeast of Tom Price Junction, 22°21'S 117°54'E, CVA volunteers.

Elodina padusa was previously recorded flying in November in the Pilbara region (Dunn and Dunn 1991). The range of sampling dates for the Malaise traps indicate that the species flies in both October/November and May.

Elodina walkeri Butler

Material examined. 1 ♂, 28.x.2005-2.xi.2005, Juna Downs Access Rd, 5.3 km east of Juna Downs Station, 22°52'S 118°31'E, CVA volunteers.

On mainland Western Australia, *E. walkeri* has been recorded only from the Mitchell Plateau via Kununurra, in the extreme north of the State (Dunn and Dunn 1991). The above specimen extends the State range in a southwesterly direction by nearly 1400 km.

Delias aganippe (Donovan)

Material examined. 1 ♂, 31.v.2004, Mt Nameless near Tom Price, 22°43'S 117°45'E, D. Britton, (netted).

Talbot (1937) made vague reference to a specimen (in The Natural History Museum, London) from somewhere between Carnarvon and Fortescue River. Carnarvon was previously recognised as the northern limit of the range of *D. aganippe* in Western Australia (Common and Waterhouse 1981). Williams *et al.* (1993) have since recorded it from Learmonth, 300 km to the north of Carnarvon. Our record of a hill-topping male increases the range inland and to the east of Learmonth by approximately 384 km.

NYMPHALIDAE

Hypolimnas bolina nerina (Fabricius)

A single male was observed at Mount Robinson, 23°02'S 118°51'E, on 26.v.2006 at an altitude of ~520 m. In the Pilbara region, *H. b. nerina* has been recorded from Onslow on the coast (Common and Waterhouse 1981). Another specimen has been recorded from Mount Augustus National Park in the Gascoyne region (Williams *et al.* 1993). Our observation indicates that the inland range of this species extends at least a further 250 km to the northeast.

Vanessa kershawi (McCoy)

Material examined. 1 ♀, 28.x.2005-2.xi.2005, 2.5 km southeast of Hamersley station, 22°18'S 117°41'E, CVA volunteers.

Vanessa kershawi has only been recorded flying in May in the Pilbara region. The above specimen indicates that it also flies in October/November.

Euploea core corinna (Cramer)

Material examined. 1 ♀, ex-pupa, emerged 7.iii.2006, Dales Gorge, Karijini N.P., 22°28'S 118°37'E, A. Donnelly & A. Hegedus.

Onslow is the nearest previous record to the Pilbara region for this species (Common and Waterhouse 1981). The above pupa was located on grass, which is presumed not to be the food plant. This record extends the distribution of this species inland by approximately 370 km.

LYCAENIDAE

Ogyris oreotes (Hewitson)

Material examined. 1 ♀, 29.v.2004, Nanutarra-Wittenoom Rd, 1.7 km north of Hamersley Rd turn off, 22°13'S 117°58'E, D. Britton & A. Donnelly (netted).

Ogyris oreotes populations from southwestern Western Australia have been placed in subspecies *O. o. apiculata* Quick, but those from the few isolated records further north are supposed to belong to the 'arid form' (Braby 2000). This is based largely on male fascies and it is not possible to determine if the above specimen, a worn female, is of the 'arid form'. A previous male recorded from the Hamersley Range (Common and Waterhouse 1981) corresponds to the 'arid form' description. The above female extends the known flight period (September-November, January, March and April: Dunn and Dunn 1991) to late May in Western Australia.

Ogyris amaryllis meridionalis (Bethune-Baker)

Material examined. 1 ♂, 19.ii.2005, Mt Nameless, near Tom Price, 800 m, 22°43'S 117°44'E, S. Ginn & M. Bulbert (netted).

In Western Australia, *O. a. meridionalis* has previously been recorded in April, June and November (Dunn and Dunn 1991, Williams *et al.* 2006).

Jalmenus clementi H.H. Druce

Material examined. 1 ♀, 16-24.xi.2004, Juna Downs Access Rd, 5.3 km east of Juna Downs Station, 22°52'S 118°31'E, CVA volunteers; 1 ♂, 16-20.ii.2005, 13.9 km northeast of Tom Price Junction, Nanutarra-Munjina Road, 22°26'S 117°49'E, M. Bulbert & S. Ginn; 1 ♂, 18.ii.2005, 4 ♂♂, 1 ♀, 20.ii.2005, Hamersley Homestead, 50 km north of Tom Price, 22°16'S 117°41'E, M. Bulbert & S. Ginn (netted); 2 ♂♂, 1 ♀, 20.ii.2005, 15 km north of Tom Price, 22°40'S 117°46'E, M. Bulbert & S. Ginn (netted); 5 ♂♂, 19-24.v.2005, 1 ♀, 22-27.ix.2005, 1 ♂, 6-11.vii.2005, 2 ♂♂, 2 ♀♀, 12-17.viii.2005, 2 ♂♂, 1 ♀, 28.x.2005-2.xi.2005, 4 km southwest of Tom Price Junction, Nanutarra-Munjina Road, 22°29'S 117°41'E, CVA volunteers; 5 ♂♂, 1 ♀, 13-18.iv.2005, 4 km southwest of Tom Price Junction, Nanutarra-Munjina Road, 22°29'S 117°41'E, M. Bulbert & G. Wood; 1 ♂, 1 ♀, 26.v.2004, 10 km north from Tom Price turnoff along Nanutarra-Wittenoom Rd. on left side, 22°32'S 117°38'E, D. Britton (netted); 1 ♂, 3-8.i.2006, Great Northern Highway 24 km north of Juna Downs exit, 22°41'S 118°42'E, A. Donnelly & CVA; 5 ♂♂, 2 ♀♀, 3-8.i.2006, Nanutarra-Munjina Rd, 4 km south-west of Tom Price Junction, 22°29'S 117°41'E, A. Donnelly & CVA; 1 ♀, 15.v.2006-19.v.2006, Nanutarra-Wittenoom Rd, 26.6 km northeast of Tom Price Junction, CVA volunteers.

Jalmenus clementi is endemic to the Pilbara and neighbouring regions, including Tom Price (Dunn and Dunn 1991). The flight period has been recorded as September to June (Braby 2000); survey data indicate that this species also flies in mid-August. *J. clementi* is locally common and well adapted to the extreme conditions of the Pilbara region. In February, specimens were observed in flight in temperatures above 40°C. As noted by Braby (2000), there was considerable variation observed in size. Specimens examined in this study had single forewing lengths ranging from 12.5 to 17.9 mm, with an overall mean and mean standard error of 15.2 ± 0.3 mm. The source of this variation is unclear, as there were insufficient specimens to enable further correlation with seasonal or other factors.

Candalides erinus (Fabricius)

Material examined. 1 ♂, 28.x.2005-2.xi.2005, 4 km southwest of Tom Price Junction, Nanutarra-Munjina Road, 22°29'S 117°41'E , CVA volunteers.

Candalides erinus has been recorded as a coastal species in the Pilbara Region. Its most southerly record in Western Australia is 16 km south of Onslow (Dunn and Dunn 1991). The specimen collected during the current survey increases the species' range inland approximately 300 km in a southeasterly direction.

Candalides heathi heathi (Cox)

Material examined. 2 ♀♀, 3-8.i.2006, Great Northern Highway 24 km north of Juna Downs exit, 22°41'S 118°42'E, A. Donnelly & CVA.

In the Pilbara region, this species has been recorded at Wittenoom. The above record extends its range southwards by approximately 50 km. *C. h. heathi* has been recorded in this region in the months of August, October, February, May and June (Dunn and Dunn 1991) and, in this survey, January.

Nacaduba biocellata biocellata (C. & R. Felder)

In most parts of Australia, *N. b. biocellata* flies throughout the year. It has been recorded flying in September, October, April and May in the Pilbara region (Dunn and Dunn 1991). The species was abundant in samples throughout the surveyed region (78 ♂♂, 23 ♀♀) and from this we can confirm that it flies throughout the year in the Pilbara.

Theclinesthes miskini miskini (T.P. Lucas)

The flight period for *T. m. miskini* is throughout the year in the Northern Territory (Braby 2000). Flight periods for Western Australia are July to November and May (Dunn and Dunn 1991). A large number of specimens (73 ♂♂, 23 ♀♀) of *T. m. miskini* were captured during the survey period throughout the surveyed region, indicating that adults also fly during February and April.

Theclinesthes serpentata serpentata (Herrich-Shäffer)

Material examined. 1 ♂, 22.iii.2006, Tom Price, hill adjacent to truck monument, Tom Price-Paraburdoo Rd junction, 22°41'S 117°47'E, S. Ginn, (netted).

T. s. serpentata has been recorded from Roebourne on the Pilbara coast (Braby 2000) and from Broome (Peters 2006), which represents the northern limit of the species in Western Australia. The northernmost inland record in the State is 62 km south of Mt Augustus (Williams *et al.* 1993). Our March specimen from Tom Price extends the inland range approximately 220 km southeast of Roebourne. This species has previously been recorded flying in May in the Pilbara (Dunn and Dunn 1991).

Zizina labradus labradus (Godart)

Records for *Z. l. labradus* in the Pilbara region have generally been from coastal locations. The species was abundant in samples throughout the surveyed region (157 ♂♂, 65 ♀♀) and confirms that the species' range extends inland at least 250 km. In other parts of Australia it flies throughout the year. In the Pilbara region, *Z. l. labradus* has been collected in August, October, April and May (Dunn and Dunn 1991). Records from our survey add September, November, February and June to the temporal data for this species.

Famegana alsulus alsulus (Herrich-Schäffer)

Material examined. 1 ♂, 12-17.viii.2005, Juna Downs Access Rd, 5.3 km east of Juna Downs Station, 22°52'S 118°31'E, CVA volunteers; 2 ♂♂, 15.v.2006-19.v.2006, Nanutarra-Wittenoom Rd, 10.8 km northeast of Tom Price Junction, 22°26'S 117°48'E, CVA volunteers.

F. a. alsulus has been recorded previously from Wittenoom (Dunn and Dunn 1991). The above records extend its range approximately 75 km to the southeast.

Zizula hylax attenuata (T.P. Lucas).

Material examined. 1 ♂, 26.v.2004, 10 km N from Tom Price turnoff along Nanutarra-Wittenoom Rd. on left side, 22°32'S 117°38', E, D. Britton, (netted); 1 ♂, 15.v.2006 – 19.v.2006, Nanutarra-Wittenoom Rd, 10.8 km northeast of Tom Price Junction, 22°26'S 117°48'E, CVA volunteers.

This species has not been recorded previously from Western Australia. The Pilbara record extends its range from Darwin, Northern Territory to the southwest by approximately 1700 km.

Other species

Belenois java teutonia (Fabricius), *Junonia villida calybe* (Godart), *Danaus petilia* (Stoll), *Papilio demoleus sthenelus* W.S. Macleay, *Catopsilia pomona* (Fabricius) and *Eurema smilax* (Donovan) were also collected during the study.

Discussion

This study has expanded the number of butterfly species known from the Hamersley subregion of the Pilbara from nine to 24. The new distribution records indicate that many northern species have ranges that extend much further south than previously thought, and that many species previously considered to be coastal in distribution extend their ranges inland. The majority of species were recorded flying outside their previously published flight periods for this region (Dunn and Dunn 1991, Braby 2000).

The new range records provided for some species in this study can be related to existing knowledge of food plant distributions in Western Australia. Published food plant records were obtained from the literature (as reviewed in Braby 2000) and compared with food plant distributions from FloraBase (2006).

In Western Australia, the recorded food plant of *Proeidosa polysema* is soft spinifex *Triodia pungens* (Braby 2000). *T. pungens* is widely distributed throughout the northern part of the Pilbara region (Florabase 2006), so it is reasonable to assume that other isolated populations of *P. polysema* exist.

Meyer (1996) and Muller (1998) found that *Capparis sepiaria* L. (Capparaceae) is the food plant for *Elodina walkeri* in the Northern Territory and Queensland, but in Western Australia this plant is restricted to areas north of Broome (Florabase 2006). Three other *Capparis* species occur in the Pilbara (Florabase 2006) and it is probable that *E. walkeri* is utilising one or more of these.

Jalmenus clementi has been recorded on three *Acacia* (Mimosaceae) species: *A. alexandri* Maslin, *A. inaequilatera* Domin and *A. tetragonophylla* F.Muell. (Braby 2000). Of these, *A. inaequilatera* and *A. tetragonophylla* are known to occur in the Pilbara region, although *A. tetragonophylla* appears to be more broadly distributed (Florabase 2006). Based on the observations in this study and the distribution of the food plant species, it is likely that *J. clementi* has a much broader distribution than that indicated in Braby (2000).

Larvae of *Candalides erinus* have been recorded feeding on three *Cassytha* (Lauraceae) species: *C. filiformis* L., *C. pubescens* R. Br. and *C. aurea* J.Z. Weber (Braby 2000). Of these, only *C. filiformis* is known to occur widely in the Pilbara and is likely to be the larval food plant for populations of *C. erinus* in this region.

Braby (1997) observed females of *Zizula hylax attenuata* laying eggs on *Dipteracanthus australasicus* F.Muell. (Acanthaceae) in brigalow woodlands near Wandoan, Queensland. *D. australasicus* occurs in rocky watercourses and floodplains in the Pilbara region (Florabase 2006) and is likely to be the food plant for *Z. h. attenuata* in the Pilbara. The specimens collected in this study were captured in a floodplain area, but the presence of the putative food plant was not noted at the time.

An unidentified *Euploea* sp. was observed at Dales Gorge on 19.ii.2005. A specimen of *E. c. corinna* was also sighted on 2.vi.2006 at the same location. These specimens, along with the one collected as a pupa (see results), confirm the existence of a population in Dales Gorge. Numerous food plants are known for *E. c. corinna* (summarised in Braby 2000). The most likely food plant at Dales Gorge is large fig trees, *Ficus* sp., although no larvae were found on these during searches conducted during the June 2006 survey.

The systematic sampling at fixed localities using Malaise traps provided many of the new records in this study. Malaise traps are passive devices that exploit the tendency for partially confined aerial insects to fly up towards light. However, they are rarely used to examine lepidopteran diversity (Maeto and Makihara 1999), although they have been effectively used to monitor migratory patterns of some butterflies (Walker 2001). This may be due to the perceived damage incurred by immersing the specimens in wet preservatives or, in the case of dry jar Malaise traps, the mechanical damage caused by other large insects such as beetles and grasshoppers entering the trap. Such damage can make identifications difficult as wing scales are easily detached. Information on the temporal and spatial distribution of butterfly species are typically compiled from records attained by opportunistic netting and regularly walked transects (Pollard and Yates 1993, New 1998).

In this study, we found that Malaise traps with a non-abrasive preservative such as ethylene glycol can be used effectively to collect butterflies. Only two specimens out of the 526 collected during the survey could not be identified due to damage. Although Malaise trapping was successful for this project, it is not our intention to suggest this should replace conventional methods; to do so could potentially lead to an underestimate of diversity and seasonality. Inuoe and Maeto (2002) have shown that species diversity and abundance can be underestimated if only flight intercept traps are used. This suggestion is supported by our own results, where seven of the species recorded were not collected by Malaise traps. However, we suggest that they are a valuable method for gathering information in remote areas, especially when supplemented with other survey methods.

Conventional butterfly survey methods require personnel to actively and regularly visit study areas. This can be time consuming and labour intensive, especially if sites are remote. Conventional transect methods may not be feasible for long-term studies in remote locations. Malaise traps, in contrast, have the advantages of requiring little time to erect, a longer sampling period (*e.g.* five days per site) and multiple traps running simultaneously at different locations. Personnel erecting traps do not need to be trained in the identification of butterflies, hence volunteers and other local persons can be used to erect and clear traps. The end result is that a number of spatially remote sites can be sampled at the same time with reduced labour and other logistic costs.

It is hoped that this approach will lead to more systematic studies of insect populations, including butterflies, in the remote areas of Australia. The new distribution records presented here indicate that there is much more work needed in remote parts of Australia before a good understanding of the broad-scale distribution and seasonality of Australian butterflies is obtained.

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References

BRABY, M.F. 1997. New larval food plants for some butterflies (Lepidoptera) from northern and central Queensland, Australia. *Australian Entomologist* **24**: 97-108.

BRABY, M.F. 2000. *The butterflies of Australia: their identification, biology and distribution.* CSIRO Publishing, Collingwood, Victoria; xx + 976 pp.

COMMON, I.F.B. and WATERHOUSE, D.F. 1981. *Butterflies of Australia.* Angus & Robertson, Sydney; xiv + 682 pp, 49 pls.

DUNN, K.L. and DUNN, L.E. 1991. *Review of Australian butterflies: distribution, life history and taxonomy.* Parts 1- 4. Published privately, Melbourne; 660 pp.

FLORABASE, 2006. (Accessed 19 January 2006). *http://florabase.calm.wa.gov.au/*

INUOE, T. and MAETO, K. 2002. What is the purpose of using insect traps? *Nature and Insects* **37**: 2-7.

JOHNSON, S.J. and VALENTINE, P.S. 2004. Butterfly field notes from northwestern Australia including new distributions of several species. *Victorian Entomologist* **34**: 58-59.

MAETO, K. and MAKIHARA, H. 1999. Change in insect assemblages with secondary succession of temperate deciduous forests after clear-cutting. *Japanese Journal of Entomology* **2**: 11-26.

MEYER, C.E. 1996. Butterfly larval food plant list for the Northern Territory and the Kununurra district in Western Australia. *Victorian Entomologist* **26**: 66-72.

MULLER, C.J. 1998. New larval foodplant records for butterflies (Lepidoptera) in northern Queensland. *Australian Entomologist* **25**: 33-38.

NATUREBASE, 2006. (Accessed 9 March 2006). *http://www.naturebase.net/*

NEW, T.R. 1998. *Butterfly conservation.* Second Edition, Oxford University Press, Melbourne; 260 pp.

PETERS, J.V. 2006. New distribution records for Australian butterflies (Lepidoptera). *Australian Entomologist* **33**: 113-114.

POLLARD, E. and YATES, T.J. 1993. *Monitoring butterflies for ecology and conservation.* Chapman & Hall, London; 274 pp.

TALBOT, G. 1937. *A monograph of the pierine genus* Delias *Hübner*. Part VI, pp 261-656. British Museum (Natural History), London.

WALKER, T.J. 2001. Butterfly migrations in Florida: seasonal patterns and long-term changes. *Environmental Entomology* **30**: 1052-1060.

WILLIAMS, A.A.E., WILLIAMS, M.R., HAY, R.W. and TOMLINSON, A.G. 1993. Some distribution records and natural history notes on butterflies from Western Australia. *Victorian Entomologist* **23:** 126-131.

WILLIAMS, A.A.E., WILLIAMS, M.R. and SWANN, G. 2006. Records of butterflies (Lepidoptera) from the Kimberley Region of Western Australia. *Victorian Entomologist* **36**: 8-16.

WILLIAMS, A.A.E., WILLIAMS, M.R., TOMLINSON, A.G. and LUNDSTROM, T.D. 1996. Records of butterflies from the central desert region and semi-arid areas of Western Australia. *Victorian Entomologist* **26**: 29-34.